ANS®
American Nuclear Society

Certified Nuclear Professional

Candidate Handbook

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Responsibility of the Candidate

It is the responsibility of each candidate to read and understand the contents of this handbook before applying for an examination. This handbook contains current information about the policies and procedures of the certification program, eligibility criteria, exam content outline, and the reference materials used to develop each examination. It is essential that each candidate keep this handbook readily available for reference until the entire certification process, including score reporting, is completed.

Introduction to the Certification Program

The American Nuclear Society (ANS) Certification and Workforce Development Committee (CWDC) was established in the ANS Bylaws and Rules with the purpose of developing and implementing a professional credentialing and workforce development program to support the goals of ANS. The CWDC operates independently of any internal or external entity as the certifying body responsible for the voluntary certification program. Its autonomy ensures the protection of the certification program's integrity against undue influence.

The Certified Nuclear Professional (CNP) program aims to:

- Establish professional standards for certified nuclear professionals.
- Provide a means for measuring an individual's knowledge against a predetermined standard.

The certification program establishes industry standards and serves as a comprehensive measure of knowledge in the field. The CNP designation distinguishes nuclear professionals who have met an established standard of knowledge and understanding of nuclear fundamentals, safety, codes and standards, health physics, licensing and regulatory concepts, fuel cycle and waste management, and non-power nuclear technology.

The CNP designation provides employers and the public with the assurance that certified individuals possess the necessary job skills, knowledge, and experience in the nuclear field to perform their duties competently.

Who Should Take the Certification Examination

The CNP certification is recommended for individuals who have at least two years of professional experience in the nuclear industry and are seeking to validate their knowledge and commitment to excellence in this critical field. The certification is well-suited for early- to mid-career professionals working in areas such as nuclear operations, regulatory compliance, quality assurance, safety, or project management.

Eligibility Requirements

Candidates must meet the following eligibility requirements at the time of application. The CWDC reserves the right to conduct random audits to verify candidate eligibility, including but not limited to contacting references. Any candidate deemed ineligible at the time of application will forfeit the $125 application fee.

CNP Examination

At the time of application, the candidate must meet the following requirements:

1. Hold a high school diploma or GED equivalent as a minimum AND
2. Demonstrate completion of nuclear education or work experience; this includes
    - Two (2) years of nuclear on-the-job work experience OR
    - Eighty (80) hours of ANS instructional education OR
    - Two (2) years of nuclear education completed at an associate-degree level or above. Alternative options to fulfill the nuclear education requirement could include the following:
        - Possession of a Senior Reactor Operator (SRO) License or Reactor Operator (RO) license,
        - Completion of the U.S. Navy's Nuclear Power School (enlisted or officer) or operator training at a prototype school, or
        - Other forms of nuclear education or coursework, which will be considered on a case-by-case basis.

About the Examination

The CWDC partners with Strasz Assessment, an independent assessment company that supports exam administration and scoring, along with Smithbucklin, an association management company that assists with exam development and developing professional credentialing programs.

The CNP exam consists of 100 questions. Candidates will have 2 hours and 30 minutes to complete this exam. A variety of question types will be used including single-answer, multiple choice; multiple-answer multiple choice; matching; or drag-and-drop type. Each question is equally weighted, the answer is either fully correct or incorrect. The eligibility requirements and examination content for a CNP certification are based on a comprehensive study of current roles and responsibilities of professionals working in the nuclear field. A national job task analysis (JTA) was conducted to identify the essential knowledge, skills, and competencies required for successful performance across a broad range of positions in the nuclear industry. Based on the results of this analysis, a panel of subject matter experts from diverse sectors of the field—including operations, safety, engineering, licensing, and regulatory compliance—defined the scope of practice and established the content areas appropriate for the examination. The CNP

examination reflects the real-world knowledge and competencies necessary for professionals to perform effectively and responsibly in nuclear environments.

To ensure the examination remains current and valid, a job task analysis is conducted every five to seven years or as needed when significant changes occur in the profession. During this process, industry professionals validate the relevance of existing content and identify new or evolving areas of practice. The examination is reviewed and updated in accordance with national testing standards to maintain fairness, accuracy, and psychometric integrity.

Accommodations for Special Needs (Americans with Disabilities Act)

ANS is committed to providing reasonable and appropriate accommodations in compliance with the Americans with Disabilities Act Amendments Act (ADAAA) for individuals with documented disabilities. These accommodations ensure that all candidates have equal access to examination functions, regardless of location, including outside the United States.

Candidates requesting special testing accommodation must provide documentation of their disability and functional limitations from a qualified medical professional, such as a physician, healthcare provider, or other relevant specialist. This documentation must be on official letterhead and must:

- clearly describe the nature and extent of the disability,
- explain how the disability affects the candidate's ability to take the examination under standard conditions,
- and include specific recommendations for reasonable accommodation with a clear rationale for each request.

Candidates must submit requests for accommodation at the time of application and no later than eight (8) weeks before the start of a testing period. Requests such as "extra time," "extra breaks," or "maximum allowable time" must be supported with specific documentation justifying the need.

The certification program reserves the right to request additional documentation or clarification as necessary to ensure fair and appropriate accommodation.

Statement of Nondiscrimination

The CWDC and ANS do not discriminate against any individual or entity on the basis of religion, age, gender, race, disability, nationality, creed, socioeconomic status, or any other proctored classification. All individuals submitting an examination application will be judged solely on published criteria. Candidates are not required to be a member of any industry organization to apply for ANS certification.

Copyright Information

All proprietary information rights to the CNP exam, including copyright, are held by ANS. In order to protect the validity of the scores reported, candidates must adhere to strict guidelines regarding proper conduct in handling these copyrighted proprietary materials. The law strictly prohibits any attempt to reproduce all or part of the CNP exam. Such attempts may include, but are not limited to, removing materials from the testing room; aiding others by any means in reconstructing any portion of the exam; posting content on any discussion forum; and selling, distributing, receiving, or having unauthorized possession of any portion of the exam. Alleged copyright infringements will be investigated and, if warranted, prosecuted to the fullest extent of the law. It should be noted that examination scores might become invalid in the event of this type of suspected breach. Permanent revocation of certification may occur if allegations are substantiated.

Application Instructions

See the Certified Nuclear Professional (CNP) page for application instructions.

Examination Fees

ANS Members	$395
Non-Members	$595
Other Fees (see conditions below)	
Rescheduling, Transfer, and Cancellation Fee	$125
Retake Fee ANS Members	$295
Retake Fee Non-Members	$495
Administrative Fee for Returned Checks	$30

VISA, MasterCard, Discover, and American Express are accepted.

Payment is collected online at the time an application is submitted. Contact certification@ans.org if you need to use an alternate method for submitting payment.

Faxed or emailed application submissions will not be accepted.

Rescheduling of Exam Appointments

Requests for rescheduling an examination appointment to a different date within the same testing period must be submitted directly to Pearson VUE through the scheduling web link listed on your Exam Appointment (EA) email. If you reschedule at least 72 hours before your appointment and use the Pearson VUE online portal, there is no fee. If you do not use the online portal for rescheduling,

you will be charged a $125 rescheduling fee. Rescheduling is not permitted after the 72-hour cut-off point.

Transferring Your Exam Appointment

Requests for transferring an examination appointment to a different testing period must be submitted by following the instructions provided by Pearson VUE testing service. All transfers of examinations to a different period are subject to a $125 transfer fee.

Failure to keep an appointment or cancelling an appointment without the appropriate notice (fewer than two weeks before the scheduled appointment) will result in forfeiture of all applicable exam fees.

You may transfer your exam to the next testing period up to two times. Upon transferring your exam, you are no longer eligible for a refund and will forfeit all applicable exam fees should you decide to cancel your exam after it has been transferred to a later testing period. If you wish to transfer your examination further than two testing periods from the original application, you must submit for a cancellation and refund and resubmit a new application.

Cancellations/Refunds

ANS must receive all requests for a cancellation/refund in writing, no later than two weeks before the start of your original testing period. If you have previously transferred your exam to a new testing period, you are not eligible for a refund.

You may email a request for a refund to certification@ans.org. Requests for cancellations/refunds may only be made by the exam candidate. Refunds will be issued minus a $125 processing fee.

Re-Examination

Certification exams may only be taken once during a testing period. However, exams may be taken in subsequent testing periods, upon submission of a new application and payment of new examination fees. Candidates may take an exam up to 3 times within a 12-month period. If a candidate does not pass the exam upon their third attempt, there will be a waiting period of one year to reapply to take the exam. With each new application submission, candidates will be required to meet the eligibility requirements in effect at the time of submission.

Scheduling Your Exam Appointment

To start the scheduling process, please visit the online Pearson VUE portal using the link that was provided to you in your Pearson VUE confirmation email.

Either create a user profile with Pearson VUE or sign in using your existing Pearson VUE account. The system will take you to the scheduling portal and show you the examinations for which you are eligible. Based on your address or using a location that you enter into the system, Pearson will show the closest three centers to you. You can change the range of centers by changing the search at the top of the screen.

You may select up to three test centers to see availability at the testing centers. The available dates and times are presented; please select the preferred test center, along with a date/time using the calendar screen.

If no appointments are available at a center during the time you are authorized, you will need to pick a different center.

Once you select a date/time, you will be presented with information about your appointment. Please review the details before you confirm your appointment. Once confirmed, you will receive a final confirmation screen and an email with the exam details, test center location, directions to the test center, and testing policies. Making additional changes after confirmation may result in additional fees.

Day of the Exam

In-Person Testing Center Appointments

It is strongly recommended that you familiarize yourself with the testing center location and parking facilities before the day of your exam so that you arrive at the testing center stress-free and on time.

On the day of the exam, report to the testing center at the time indicated in your email confirmation notice. Late arrivals will not be admitted subject to testing center rules.

Upon arriving at the testing center, you will be required to present your confirmation email and provide one form of current government-issued photo identification, which must bear your name and your signature. The name on your photo identification must exactly match the name that appears on your confirmation email. Examples of appropriate identification include a passport or driver's license; a military identification is not an allowed form of identification. If you do not bring the appropriate identification to the testing center, you will not be able to test within that testing period. A test-site administrator will provide a brief orientation and then escort you to a workstation. You may only leave your workstation when authorized by a test-site administrator. If you leave your workstation during the exam, extra time will not be provided, and your examination may be terminated at the discretion of the proctor.

In the event that internet connectivity is lost, your submitted answers will not be lost, and the computer will stop the clock on your exam at the time connectivity is lost. The clock will resume when connectivity is re-established, and you will be able to complete the exam in the fully allotted

time period. You must notify the test-site administrator if internet connectivity is lost. The test-site administrator will be able to contact Pearson VUE should the need arise.

Contact a test-site administrator if you believe there is a problem with your computer or if you require other assistance.

Examination Policies

To ensure all exams are taken under comparable conditions, it is necessary to maintain a standardized testing environment. The following recommendations, policies, and procedures pertain to every exam candidate:

- Instructions by testing center personnel and proctors are to be followed.
- An on-screen clock will be provided and will display the allotted time for the exam. You will not be permitted to continue beyond the allotted time limit.
- Do not bring any books or reference materials into the testing room. The testing center administrator will not permit anyone found possessing such materials to continue the exam, and you will forfeit all applicable examination fees. For online remote proctoring, your proctor via webcam will ensure that your testing space is secure and that no books or reference materials are present.
- Electronic devices (cell phones, pagers, tablets, etc.) are not permitted in the testing room. A scientific calculator will be included with the examination software for your use.
- Visitors are not permitted at the testing center.
- Bring a jacket or sweater without a hood or pockets for air-conditioned rooms.

Note: On rare occasions, major technical problems with computer equipment at the testing center may require rescheduling of an examination at the testing center administrator's discretion. In these cases, no additional fee will be charged.

During the Exam

During the exam, examinees have the opportunity to, if time permits, review and change previously answered or skipped questions. Once you click "submit", you will no longer be able to review any questions.

Once your allotted time has expired or you exit the exam, you cannot see or review the questions again. As a reminder, should internet connectivity be lost during the exam, the clock will be stopped, but your answers will not be lost.

Pearson VUE provides detailed information about the exam process, and we highly recommend your review it ahead of time: https://www.pearsonvue.com/us/en/test-takers/resources.html and https://www.pearsonvue.com/us/en/test-takers/demo-test.html.

Exam Security/Grounds for Dismissal

The CWDC and Strasz/Pearson VUE maintain established test administration and security standards to ensure that all candidates are provided with a fair and consistent opportunity to demonstrate their knowledge, skills, and abilities.

Any candidate who does not have positive identification, uses unauthorized aids, engages in misconduct, or does not follow testing procedures will be dismissed from the examination. The CWDC may choose to have test scores of such candidates cancelled, in which case all applicable exam fees will be forfeited. The following are examples of behaviors considered to be misconduct and will not be tolerated during the administration of the CNP exam:

- Giving or receiving assistance of any kind;
- Using references or aids;
- Attempting to take the exam for someone else;
- Failing to follow testing regulations and/or test proctor instructions;
- Creating disturbances;
- Copying or attempting to remove exam questions and/or scratch paper from the exam room;
- Tampering with testing center computers;
- Leaving the exam room without permission;
- Using electronic communication devices (cell phones, tablets, smart watches, etc.).

Scoring Information

The pass/fail cut-off score is determined using a criterion-reference method, which allows the performance of each candidate taking the exam to be judged against a predetermined standard rather than against other candidates. The predetermined standard is set through a process of statistical equating, taking into account actual candidate performance across test cycles, to ensure the validity, reliability, and legal defensibility of the exam.

When your exam time expires, all questions will be included in the final calculation of your score, even if they are blank or marked for review.

The exam uses scaled scoring.

Exam Results

Exam results will be provided 6-8 weeks following the testing period.

Applicant/Candidate Appeals

Decisions by the CWDC regarding initial determination of eligibility to take an examination, continued certification, disruptive examination conditions (e.g. if the power goes out at testing facility), and verification of an examination score may be appealed to the CWDC. Failure to pass the examination is not in itself grounds for appeal. The grounds for appeal to the CWDC are only those stated in the previous sentence.

An appeal to the CWDC must be made in writing by email, with the subject line "Appeal" to certification@ans.org.

All such exam appeals must be received by the CWDC within 30 days of the date that (1) the CWDC provided notice denying eligibility to take the examination or (2) the date the CWDC provided notice denying continued certification, or (3) the date on which a disruptive examination condition or examination occurred, or (4) that the candidate received official notice of the examination score. The written appeal must identify the precise factual basis, applicable rules, or examination conditions that are the basis for the appeal.

Attainment of Certification

Certification is valid for three years. Candidates who pass the certification exam may use the appropriate "CNP" designation upon receipt of official examination results that indicate a passing score. Newly certified individuals will receive a CNP certificate.

Recertification

Recertification is intended to ensure continued competence through the ongoing development of knowledge and skills in the nuclear field. The process reinforces a commitment to professional growth, safety, regulatory awareness, and evolving industry practices. All Certified Nuclear Professionals (CNPs) are required to renew their certification every three years, with the certification cycle ending on December 31 of the third year following initial certification or the most recent renewal.

To maintain the CNP credential, certificants must meet the following recertification requirements:

- Complete 36 hours of continuing education (CE) relevant to the CNP body of knowledge during the 3-year certification period; and
- Submit a renewal application and pay the required fee ($295 for ANS Members/$495 for nonmembers); and
- Reaffirm adherence to the ANS Code of Ethics and Respectful Behavior Policy

As an alternative to submitting CE hours, certificants may choose to renew by examination. This option requires the individual to meet all other renewal requirements and successfully pass the current version of the CNP examination under the eligibility criteria in effect at the time of renewal.

All certificants are responsible for tracking their own recertification dates and maintaining records of their continuing education or examination activities. Continuing education must be relevant to the core competencies of the CNP program and aligned with professional roles and new or more recent information stemming from the nuclear industry.

For full details on approved continuing education activities, documentation requirements, or to access the renewal application, please visit the Certified Nuclear Professional (CNP) Certification page.

CNP Standards of Conduct and Ethics

ANS certificants are expected to uphold the highest ethical standards, ensuring safety, integrity, and accountability in the nuclear industry. Individuals who hold an ANS designation shall subscribe to the American Nuclear Society (ANS) Code of Ethics, reinforcing the core principles that guide the behavior of professionals in the field of nuclear science and technology.

Certificants shall also subscribe to the following practices of professional conduct:

1. Represent their qualifications, skills, and competencies accurately, ensuring no misrepresentation in their certification status.
2. Maintain a high level of professional competence and continuous learning to improve their skills and knowledge.
3. Strive for excellence by maintaining up-to-date knowledge in the nuclear field.
4. Avoid any involvement in activities that could bring the certification program or the profession into disrepute.
5. Respect confidentiality agreements, nondisclosure agreements (NDA), and avoid sharing privileged information without proper authorization.
6. Ensure that confidential information is handled with care and only disclosed when required by law or with the explicit consent of all relevant parties.

Reference Materials

Exam questions are based on a wide variety of publications, regulations, and resources in the nuclear field. Suggested preparation for the examination may include, but is not limited to, the following resources:

Nuclear Energy: An introduction to the Concepts, Systems, and Applications of Nuclear Processes, 7th ed., by Raymond L. Murray, Elsevier Publishers, 2014.

Nuclear Engineering: McGraw-Hill Series in Nuclear Engineering by Charles F. Bonilla, Walter H. Zinn, Literary Licensing, LLC, 2013.

Radioactive Waste Management, 2nd ed., by James H. Saling and Audeen W. Fentiman, Taylor & Francis, 2001.

2025 CNP Exam Content Outline

The following outline provides a detailed overview of the topics and concepts covered by the exam.

Nuclear Fundamentals (approximately 20% of the exam)

- Explain the fundamentals of nuclear structure and reactions.
    - Understanding of nuclear structure and stability.
    - Demonstrate understanding of nuclear reactions.
    - Calculate the energy release in nuclear reactions.
- Identify the fundamental radioactive decay processes.
    - Contrast the different types of spontaneous decay (e.g., alpha, beta, gamma, etc.)
    - Understand half-life and decay constant.
    - Recognize simple and serial radioactive decay.
    - Utilize the information in the chart of nuclides to solve nuclear problems.
    - Identify energy distribution among released particles.
- Explain the concepts related to a neutron balance.
    - Understand the neutron lifecycle/keff.
    - Use keff to describe if the reactor is subcritical, critical, or supercritical.
    - Demonstrate recognition of prompt criticality and delayed neutrons in reactor control.
- Explain ionizing radiation interaction with matter.
    - Compare ionizing and nonionizing radiation.
    - Describe the types of radiation (e.g., photon vs particle radiation).
    - Understand the types and probability of interactions.
    - Describe the energy deposited in matter.
    - Distinguish between irradiation and contamination.

General Nuclear Safety Culture (approximately 15% of the exam)

- Understand the fundamentals of nuclear safety culture.
    - List the primary human performance tools.
    - Define a safety-conscious work environment.
    - Understand your personal role and avenues for reporting safety concerns.
    - Understand the organizational culture effect on nuclear safety culture.
- Discuss the three major nuclear power accidents (TMI, Chernobyl, Fukushima).
    - Understand the accident sequence for each.
    - Understand the physical processes for each.
    - Explain the human factors/errors for each.
    - Discuss the consequences for each.
    - Apply the lessons learned for each.
- Relate specific nuclear events to corresponding industry changes and lessons learned.
    - Understand the impact of organizational structure.
    - Identify the training requirements.
    - Understand the impact of operational practices.
    - Identify communication protocols.
    - Relate source of technical requirements to the events.

Industry Codes and Standards in Nuclear Facilities (approximately 10% of the exam)

- Understand the purposes of consensus standards (e.g., American Nuclear Society, American Society of Mechanical Engineers, Institute of Electrical and Electronics Engineers, American Society of Civil Engineers).
    - Understand the need for consensus standards and how they are created.
    - Understand how consensus standards are adopted in the regulatory and design process.
- Distinguish how industry codes and standards are used in the design and the regulatory process.
    - Understand when codes and standards are requirements versus guidance.
    - Discuss the appropriate application of codes and standards to specific situations.
    - Understand the hierarchy of design requirements.

- Explain the process of qualifying structure systems and components (SSCs) for their intended use.
    - Understand seismic qualification.
    - Understand environmental qualification (10 CFR 50.49).
    - Understand safety qualification (Appendix B).
    - Understand cyber qualification.
    - Understand electromagnetic interference (EMI)/radio frequency interference (RFI) qualification.
    - Understand the difference in the process qualification and commercial grade dedication (CGD).

Applied Health Physics (approximately 10% of the exam)

- Understand the basics of dosimetry.
    - Describe the types of ionizing radiation.
    - Calculate energy deposited, absorbed dose, equivalent dose, effective dose, and cumulative dose.
    - Convert between dosimetry units (e.g., RAD, REM, Sievert and Gray).
- Understand the basics of radiation protection.
    - Identify potential radiation pathways.
    - Contrast the effect of time, distance, and shielding.
    - Examine different shielding parameters (e.g., half-thickness, tenth-thickness, shielding materials).
- Demonstrate understanding of radiation hazards.
    - Identify dose limits (e.g., whole body, organ, extremity).
    - Identify dose ranges (e.g., background, medical, accident).
    - Distinguish between individual and population dose.
    - Understand radiation postings.
    - Understand the application of linear no-threshold (LNT) model.
    - Understand the application of “as low as reasonably achievable” (ALARA) principle.
- Understand the biological effects of radiation.
    - Distinguish between acute vs. chronic dose.
    - Distinguish between stochastic and non-stochastic effects.

    - Distinguish between external vs. internal dosimetry.
- Identify the instruments used in applied health physics.
    - List the use of the different instruments.
    - Compare dosimetry vs survey equipment.
    - Describe the control and use of dosimetry.

Licensing and Regulatory Concepts (approximately 10% of the exam)

- Understand the framework of laws and regulations that govern the commercial nuclear industry.
    - Explain key elements of the Atomic Energy Act, the Energy Reorganization Act, and the Price-Anderson Act.
    - Explain where key regulatory requirements can be found (e.g., Part 20, 50, 100).
    - Demonstrate an understanding of the different types of regulatory documents (laws, rules, policy, regulatory guides, etc.), their hierarchy of application, and distinguishing between requirements and guidance.
- Describe the key attributes of the 'defense in depth' approach to designing a nuclear facility.
    - Describe the physical barriers to the release of radioactivity.
    - Describe engineering practices used to ensure high reliability of safety features and adequate safety margin (multiple barriers, quality assurance, etc.).
    - Differentiate between a deterministic and a probabilistic safety assessment method of addressing internal accidents and external events.
- Describe the typical content of a commercial facility's licensing basis.
    - Describe the relationship between a facility's design basis and its licensing basis.
    - List the types of documents that are typically included in a facility's current licensing basis.
    - Describe the high-level content (chapter titles) of a Final Safety Analysis Report (FSAR) for operating reactors.
- Describe the process(es) available for changing the licensing basis of a facility.
    - Describe the key regulations related to requesting a change to a facility's license.
    - List activities (proposed changes) that require prior Nuclear Regulatory Commission (NRC) approval.

    - Describe the main steps of the license amendment request process.
- Understand the key aspects of the Nuclear Regulatory Commission (NRC) license renewal process.
    - Describe the key regulations related to renewing a facility's license (e.g., Parts 51 and 54.
    - Demonstrate an understanding of the primary guidance documents related to the safety assessment aspect of license renewal.
    - Describe examples of the types of environmental considerations reviewed with respect to license renewal.
- Recognize specified guidance documents and explain the applicability of the guidance to a nuclear facility (e.g., describe how the guidance is used).
    - Describe the relationship between the Part 50 Appendix A General Design Criteria (GDC) and the design basis of the facility.
    - Describe the relationship between the Final Safety Analysis Report (FSAR) and the Standard Review Plan (SRP).
    - Describe how Part 50 Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Facilities applies to different entities in the nuclear industry.
- Understand the key concepts and terminology associated with the main operational aspects of regulating a nuclear power facility.
    - Define the term technical specifications (TS).
    - Describe the basis for what is required to be included in a facility's TS.
    - Demonstrate an understanding of the concept of limited conditions of operation.
    - Describe the key features of the NRC Reactor Oversight Process (ROP) (i.e., demonstrate an understanding of the basic terminology and roles/responsibilities of the NRC and a licensee).
    - Demonstrate an understanding of the requirements for notifying the NRC of emergency and non-emergency events (also known as Reportability).
    - Describe the four basic Emergency Action Levels.
- Define key concepts related to the decommissioning of a nuclear facility.
    - Define the term decommissioning.
    - Describe the key steps in the decommissioning release process.

Non-Power Application of Radiation and Nuclear Technology (approximately 10% of the exam)

- Understand the design and application of radiation detectors.
    - Apply basic counting statistics to radiation detection.
    - Understand the various types of detectors and their uses.
    - Understand the fundamentals of spectroscopy.
    - Assess the source type and energy selection.
    - Describe the different source, target, and detector placement.
- Discuss the medical application of radiation and radioisotopes.
    - Comprehend the diagnostic and imaging usages of radiation and radioisotopes.
    - Comprehend the therapeutic usages of radiation and radioisotopes.
- Discuss the industrial application of radiation and radioisotopes.
    - Differentiate among the usage of radiation and radioisotopes in radiotracers, radiogauges, and elemental or isotopic analysis.
    - Describe the utilization of radiation in radiography.
    - Recognize additional industrial use of industrial radiation and radioisotopes.

Nuclear Power (approximately 15% of the exam)

- Describe the basic concepts in reactor design and control.
    - Understand the basic concepts of reactor control.
    - Explain the various contributors to reactivity feedback.
    - Explain the necessary components of a reactor core, such as fissile fuel, moderator, control, coolant, and reflector.
- Discuss the nature of the four reactor generations.
    - Describe the evolution of nuclear reactor technologies and compare/contrast each generation (Gen II, Gen III(+), and Gen IV).
- Describe the basic components and component functions for a pressurized water reactor (PWR).
    - Sketch a cooling loops diagram with major components, including primary loop (core, pressure vessel, pressurizer, steam generator), and secondary loop (high- and low-pressure turbines, generator, and condenser).
    - Explain the function of each component.
    - Explain how the energy of fission is converted to electricity in this system.

- Describe the basic components and component functions for a boiling water reactor (BWR).
    - Sketch a cooling loop diagram with major components, including core, pressure vessel, steam dryers/separators, high- and low-pressure turbines, generator, and condenser.
    - Explain the function of each component.
    - Explain how the energy of fission is converted to electricity in this system.
- Differentiate thermal and fast reactors.
    - Describe the characteristics and operations of a fast reactor.
    - Describe the characteristics and operations of a thermal reactor.
- Discuss and differentiate microreactors, small modular reactors, and the majority of current power reactors.
    - Describe power level and features of microreactors.
    - Describe power level and features of small modular reactors (SMRs).
    - Describe power level and features of Gen II and III power reactors.
- Recognize the basic designs of common non-BWR and PWR power reactors around the world.
    - Describe the basic design features and functions of Canada Deuterium Uranium (CANDU) reactors – heavy water moderator and coolant unenriched or low enriched uranium, and continuous refueling.
    - Describe the basic design features and functions of advanced gas reactors (AGR) – gas cooled, graphite moderated, low enriched fuel.
    - Describe the basic design features and functions of water-water energy reactors (VVER) – pressure tubes with low enriched fuel, water cooled and moderated.
- Describe the steps of refueling a light-water reactor (LWR) core.
    - Explain the need to shut down LWRs every 12-24 months.
    - Describe the general steps in a refueling outage, including shutdown, vessel head removal, connection of spent fuel pool and vessel during refueling, movement of fuel between pool and vessel, and replacement and shuffling of fuel.
    - Describe and differentiate between the two main methods that power plants currently use to store spent/used fuel, namely, spent fuel pool and dry cask storage.

Fuel Cycle and Waste Management (approximately 10% of the exam)

- Understand the major steps of the nuclear fuel cycle.
    - List the steps of the nuclear fuel cycle (i.e., mining and milling, conversion, enrichment, reactor usage, spent fuel pool, interim storage, reprocessing, and geologic disposal).
    - Explain what happens in each step of the nuclear fuel cycle.
    - Identify the different chemical and isotopic forms of the material at each step.
    - Understand the difference between an open and a closed fuel cycle.
    - Identify front-end and back-end steps.
- Recognize the unique requirements for transportation of nuclear materials.
    - Describe the different types of transport casks .
    - Recognize the different governing authorities of transport casks.
    - Explain the different modes of transportation.
- Describe and compare uranium enrichment technologies.
    - Understand the types of enrichment technologies: (1st generation: gaseous diffusion, 2nd generation: gaseous centrifuge, 3rd generation: laser enrichment).
- Explain spent fuel reprocessing.
    - Describe the reprocessing technologies (e.g., PUREX, pyroprocessing, and volatility).
    - Explain the factors that influence whether countries do reprocessing (e.g., policy, economics, proliferation concerns).
- Describe the radioactive waste types in the U.S.
    - List the types of radioactive waste in the U.S. (e.g., high-level waste and low-level waste, including the four classes of low-level waste).
    - Describe how and where each type of waste is disposed or stored in the U.S.
    - Define relative volumes of each type of waste in the U.S.
    - Explain the long-term plan for storing used nuclear fuel in the U.S.
- Understand the challenges with spent fuel waste management.
    - Understand the history of geologic repository development in the U.S.
    - Describe the basic features of the Nuclear Waste Policy Act.